Plastic Biases Blue Carbon Assessment

Yuka Uemura[1], Taichi Kato[1], Taishun Kobayashi[1], Tomoyuki Aota[1], Hotaka Kimura[1], and Gregory N. Nishihara[2,3*]

[1]Graduate School of Integrated Science and Technology, Nagasaki University, Nagasaki, Japan
[2]Organization for Marine Science and Technology, Nagasaki University, Nagasaki, Japan
[3]Applied Algal Ecology & Blue Innovation Research Unit, Fukushima Institute for Research, Education and Innovation, Fukushima 979-1521, Japan
[*]Corresponding Author E-mail: greg@nagasaki-u.ac.jp

ABSTRACT

In recent years, blue carbon, organic carbon stored in the sediments of coastal ecosystems, has attracted significant attention as a mitigation strategy for global warming. While the stored amount is typically calculated using Total Organic Carbon (TOC) as an index, concerns have been raised that the mixing of anthropogenic microplastics (MPs), which are primarily composed of carbon, into the sediments may lead to an overestimation of the actual carbon storage. Based on the hypothesis that MPs accumulate due to the flow-attenuation function of seagrass beds, thereby inflating TOC measurements. Under this premise, I aimed to quantitatively evaluate the impact of MPs on the estimation of carbon storage. Sediment cores were collected from a seagrass (*Zostera marina*) bed as the treatment site and an adjacent sandy area as the control site, both located in Arikawa Bay, Nakadori Island, Nagasaki, Japan (32°98'44.42" N, 129°12'15.44" E). Each core was sectioned from the upper layer down to a depth of 300 into three layers at 100 mm intervals. For each layer, both samples and blanks (as correction for external contamination) were collected and analyzed. MPs were extracted from the samples using the density separation method and natural organic matter was allowed to degrade using hydrogen peroxide (H_2O_2) treatment. The TOC content of the samples was measured using a TOC analyzer (soli TOC cube). The total TOC content in the sediment was 1.00 ± 0.06 % in the seagrass bed and 1.05 ± 0.15 % in the sandy area (mean ± standard error), showing no significant difference between the two sites ($p = 0.53$). On the other hand, the MP-derived TOC content was 0.01 ± 0.002 % in the seagrass bed and 0.02 ± 0.006 % in the sandy area; it was significantly higher in the sandy area ($p = 0.0006$) and exhibited a strong positive correlation with the total TOC ($\rho = 0.75$). Contrary to our hypothesis, the higher MP-derived TOC in the sandy area may be attributed to the location of the sampling site, which was situated in the inner part of the seagrass bed. Previous studies have reported that MPs are intensively trapped at the edge zone that first encounters open-sea currents, thereby reducing the amount that reaches the inner part. This suggests that the spatial structure and local hydrodynamic conditions within the seagrass bed may have regulated the distribution. Although the contribution rate of MP-derived carbon to the total TOC was limited, at 0.88 ± 0.18 % in the seagrass bed and 1.67 ± 0.33 % in the sandy area, this study demonstrated that MPs are involved in the inflation of TOC measurements. In the strict operation of carbon credit system, even a 1 to 2 % uncertainty cannot be neglected over the long term. Therefore, further spatial investigations including seagrass bed edges and verification through material analysis are indispensable for accurately defining and evaluating true blue carbon stocks.

Keywords: Blue carbon/ Microplastics/ Coastal ecosystems/ Total organic carbon